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and less than b. The most useful table, one which precludes the necessity of rearrangement or recalculation, is one which includes all three of these possible values. For the most common orthorhombic minerals such a table has been arranged with the values of a in increasing order of magnitude, the corresponding values of c and the mineral names being placed in parallel columns. Thus each mineral appears three times, and the value of a accepted by convention is underlined. The corresponding value of c in the parallel column is a very useful check in tracing the unknown mineral.

If a monoclinic mineral is held with the greatest possible number of faces vertical, the most probable mistake in orientation is the interchange of a and c axes. Hence the table is made to include both a and c as possible values of a, *i. e.*, each mineral appearing twice in the table.

Would such tables, enlarged to include all minerals for which axial ratios have been determined, be useful accessories in the work of crystallographic mineral determination with the reflecting goniometer? Would tables further enlarged to include artificial crystals be of use to the chemical crystallographer?

Before undertaking such a task one wishes to know if it is worth while, and for this reason the questions are presented. Suggestions, and the utmost freedom of criticism by teachers of crystallography, are invited.

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HOUSE AIR

TO THE EDITOR OF SCIENCE: I had occasion recently to consult the issue of SCIENCE for September 29, 1911, and read for the first time the letter on "House Air" from Professor J. Y. Bergen, of Cambridge.

He makes this statement regarding the ventilation obtained from a hot air register:

> The ventilation . . . is much better than can be obtained in summer by opening a single window to its full height.

It is doubtless known to him and should be more widely known that it is better to pull the window down a couple of inches from the top and up from the bottom when ventilation is required than to open either half only. The truth of this statement can easily be tested by holding a lighted candle at the window openings.

G. L. MANNING
ROBERT COLLEGE,
January 23, 1912

QUOTATIONS

MOST RECENT INVESTIGATIONS ON THE DETERMINATION, PRESERVATIVE ACTION AND ADMISSIBILITY OF THE USE OF BENZOIC ACID[1]

PART II[2]

I NOW come to the most important part of my work—a critical summary of the three detailed investigations on the effect of benzoic acid and of benzoates on man which have been carried out during the last four years and which now furnish us that broad basis, which I have always desired, necessary for the formation of an intelligent opinion. First, there are two great works from the American Department of Agriculture; one carried out by H. W. Wiley,[3] in 1908, the other by a commission, under the chairmanship of the distinguished chemist, Ira Remsen, consisting of the three well-known American scientists, Professor Russell H. Chittenden, of Yale University; Professor John H. Long, of Northwestern University, and Professor Christian A. Herter, of Columbia University, New York. It seems strange that a great government should publish two books, one right after the other, dealing with the same subject-matter; and we seek in vain, in the second large volume of 761 pages, for a word of explanation of this surprising fact. Wiley's work is simply ig-

[1] Translated from the *Chemiker-Zeitung*, Cöthen, November 28, 1911, pp. 1314–17.

[2] Part I. (*Chem. Ztg.*, 1911, pp. 1297–99) is a summary of the articles dealing with the isolation, qualitative and quantitative determination, natural occurrence in plants, preservative action, use and toxic effects of benzoic acid.

[3] *J. Soc. Chem. Ind.*, 28, 67 (1909).

nored in the publication of Chittenden, Long and Herter, as if it had never existed! From this it may be concluded at once that the results or conclusions of Wiley did not seem, to the second commission, worth discussing. This is so much the more surprising in that Wiley, under the authority of the Department of Agriculture, has, for years, been publishing similar investigations on boric acid, salicylic acid, etc. Under these circumstances I had at first thought of leaving Wiley's work entirely out of consideration, but since Dr. V. Gerlach, of Wiesbaden, in the third[4] of the detailed publications mentioned above, expresses his regret that he had access to only a short abstract of Wiley's investigation, a discussion of the original, which now lies before me, will be appropriate, especially as the work will become even more difficultly accessible in the future.

Wiley studied the effect of benzoic acid on six persons and that of sodium benzoate on six others. In each case a 10-day period without the preservative was followed by a 5-day period with 1 gram, then by periods of equal length with 1.5, 2.0 and 2.5 grams, each, of the preservative, and finally by another 10-day period without the preservative; *i. e.,* 40 days, in 20 of which benzoic acid was administered. Above all, it is to be regretted that the preparations were given in capsules and that the small quantities (0.25–0.5 gram) which, in practise, are most important were not administered, as the minimal dose was 1 gram; and finally, that the experiments were extended only over a relatively short time. As far as concerns the results, I cling to the good custom of not doubting an investigator's facts and analytical data; only the basis and logic of the conclusions are here discussed. From the experiments, which are reported carefully and in considerable detail in 250 pages, Wiley concludes some very disadvantageous things for benzoic acid. He finds:

> It is evident that the use of benzoic acid, either as such or in the form of sodium benzoate, is highly objectionable and that it produces grave disturbances of the metabolism and health (irritation of the stomach, nausea, headache and, in a few cases, vomiting). So much the more importance is placed on these symptoms as they were observed in healthy men, well and carefully fed. All the test persons showed a distinct loss in weight and all the more or less marked changes in metabolism shown by investigation of the urine and feces were always of such a nature that they could never be regarded as a favorable change.

In my opinion, this sentence might just as well read: Careful investigation of the urine, feces and metabolism did not show a single symptom from which a disturbance due to the partaking of benzoic acid might be deduced! That the normal condition could not be improved by benzoic acid, as Wiley seems to require, is not surprising. As Wiley is thus far the only investigator who, supported by comprehensive experiments, has formed a condemnatory opinion of benzoic acid on toxicological grounds, I have taken the trouble to criticize his work somewhat more closely and to examine the value of his arguments. The very thorough examination of the urine, which is reported in many tables, showed nothing special. Who could lay much value on the fact that in the benzoic-acid periods the amount of solid substances in the urine increases 2.3 grams, *i. e.,* from 55.5 to 57.8, when, in the first place, the diet is not strictly fixed and, secondly, the addition of 1–2 grams of benzoic acid per day almost completely covers the increase. The relation of sulphur to nitrogen, sulphuric acid to nitrogen and phosphoric acid to nitrogen remained entirely unchanged; with the arbitrary diet the variations of 1–3 per cent., either way, of the values are unavoidable. The alkylsulphuric acids remained perfectly constant, the absolute amount of urinary sulphur changed only to an insignificant degree explainable by the method of procedure; a decrease of neutral sulphur from 14 to 12.4 per cent. in the benzoic acid period and to 11.1 per cent. in the after period seems to be proved, while on the other hand the total sulphur shows an increase from 85.9 to 87.7 and 88.9 per cent. But any one wanting to

[4] "Physiologische Wirkungen der Benzoesäure und des benzoesauren Natrons," Verlag von H. Staadt, Wiesbaden, 1909.

draw any conclusions from this might just as well, instead of supposing, like Wiley, an increase of oxidation, infer that the oxidizing power of the body is distinctly increased a little by rather large doses of benzoic acid and increases still more after the excretion of the benzoic acid, a sign of an especially powerful cell activity. It is an interesting fact that the separation of benzoic acid as hippuric acid does not take place very quickly but that an after period following a rather prolonged benzoic acid diet still shows increased hippuric acid. The microscopic investigation of the urine—the method is not described in detail—was made six times in all for each of the twelve persons studied—once each in the fore and after periods and four times in the benzoic acid periods. The results are represented by numbers: 0 = nothing, 1 = very little, 2 = little, 3 = considerable, 4 = much, 5 = very much. The following substances were sought for: crystals of uric acid, oxalates and phosphates, amorphous phosphates, epithelial cells and leucocytes, hyaline cylinders, finely granulated and coarsely granulated cylinders, mucous cylinders, mucous fibers. The numbers were added for the twelve persons and divided by twelve, and the values so obtained compared in percentages! According to the mean values most of the organized elements are increased somewhat; leaving out the crystals, the leucocytes and the finely and coarsely granulated cylinders are somewhat increased, the hyaline cylinders somewhat diminished and the mucous fibers hardly appreciably increased. Considering how strongly a 2 influences the 1's and 0's which are found in greater number, it is preferable to consider more closely each individual constituent of the six series. When this is done it is found that, excepting the mucous cylinders (increase of 50 per cent.), nothing at all remains of all the construed increases. But as the mucous fibers do not markedly increase, I set no importance on the increase of the mucous cylinders. Wiley, however, concludes that there is a slight tendency towards an increase of renal activity during the benzoic acid periods. This "slight tendency" to cause everything that is possibly bad is construed everywhere that Wiley can say nothing definite. In the feces nothing remarkable was found. On an average, in the experiments with benzoic acid the feces were a trifle drier, in the benzoate experiments somewhat damper, during and after the administration of the preservative than before it was given.

That the majority of Wiley's twelve persons should have lost 0.5–2.0 kilograms on a freely chosen diet is very remarkable, and we should much like to learn more as to the principles on which the amount of food was measured. The amounts of dry substance, fat, nitrogen and calories daily taken in the individual periods vary not inconsiderably—with a "faint tendency" in most cases to decrease in the course of the forty days—which alone explains the slight decreases in weight. We do not learn why a greater regularity in the taking of food was not striven for. I reproduce some particulars concerning one person: Test Person 1 (C. W. N.) had nothing particular to complain of against benzoic acid, but found that his strength decreased markedly, so that he could hardly do his work. At the same time, however, it is stated that this person was often very hungry, that the abundant and varied food with 4,000 calories was not sufficient for him. On the other hand, it is seen from page 1090 that during the fore period this person partook of 606 grams of dry food, on the average during the total benzoic acid periods, of 590 grams, and in the after period, of only 567 grams. Why more food was not given him remains incomprehensible, as he had already decreased 0.5 kilogram in weight in the second 5-day fore period and 0.3 kilogram in the first 5-day benzoic acid period and was hungry! In this record I see nothing but decreased body weight and consequent feeling of weakness, probably increased by suggestion, resulting from a somewhat too limited consumption of food. To other persons was given 1 per cent. of the body weight in dry substance, to No. 1 only 0.87 per cent. On page 1166 we learn, to our surprise, that Person 1, who daily took about 13–14 grams of nitrogen, daily gained

(in spite of decrease in weight) 0.53 gram nitrogen in the fore period, 0.39 gram in the benzoic acid period and 1.41 grams in the after period, and therefore apparently became poorer in fat and richer in albumin. And we learn further that Person 1 did not at all stand alone in this respect. In spite of decreases in weight and disturbances of metabolism of subjective nature, five of the twelve persons increased, seven decreased, in nitrogen; in the average of all twelve experiments there was even, in all the periods and sub-periods of the 40-day test, a daily increase of 1.2–1.5 grams of nitrogen. The nitrogen was used to the best advantage; on an average for all the test persons, 7.26 per cent. was excreted in the feces in the fore period, 7.44 in the benzoic acid period and 8.16 in the after period. The phosphoric acid metabolism was hardly influenced, but it is true, as Wiley brings out, that during the benzoic acid period the phosphoric acid increases a trifle (about 3 per cent.) in the feces and decreases by about the same amount in the urine; in the after period the increase in the feces and the decrease in the urine were somewhat more marked. Wiley draws no conclusions from this. This might be considered as a poorer utilization of the phosphorus of the food, but greater guarantee as to the amount and nature of combination of the phosphorus compounds given would be necessary. That the number of blood corpuscles would also show variations was clear. Their number was greatly raised, as compared with the fore period, after 2 administrations of benzoic acid; considerably decreased, as compared with the fore period, after 3 administrations; was about the same as in the fore period after 1 administration; increased after 3 doses of sodium benzoate; decreased after 2 doses; not determined after 1 dose.

The general average for all twelve persons was as follows:

	Red Corpuscles	White Corpuscles	Hemoglobin Per Cent.
Fore period	5,082,273	7,433	96
Benzoic acid period	5,099,583	7,331	96
After period	5,255,000	6,644	97

No conclusion, therefore, for or against benzoic acid can be drawn from these data, yet Wiley speaks of a "tendency" to diminish the red corpuscles which benzoic acid seems to have!

In my honest opinion, Wiley's publication is lacking in every proof, every objective proof, of the harmfulness of benzoic acid, and from the voluminous metabolism investigations which Wiley has so pitilessly used against benzoic acid exactly the opposite conclusion may be drawn, that, at most, each and every entirely subordinate fact. (I have carefully reproduced them all above from Wiley's publication) remains somewhat doubtful in its significance. From Wiley's report on subjective symptoms of digestive disturbances by 1–2 gram quantities of benzoic acid in wafers, no conclusions can be drawn; even with this method of procedure, so ill-adapted to our problem, the data stand too isolated in the literature. They give the impression that suggestion played a considerable part in them, for there is no doubt that in Wiley's laboratory preservatives are considered with extreme mistrust and antipathy and that the test persons should imbibe some of this antipathy is easily conceivable. I surmise that this was also the general impression of the American authorities and that new investigations by Chittenden, Long and Herter were instituted to critically test Wiley's results, which were contrary to all observations so far made in the laboratory and in practise.

Although the volume of analyses and observations reported by Wiley and their evident cost are considerable, the extent of the work of the other investigators is surprising. This voluminousness of the work, especially the numberless tables, makes it difficult to enter very much into the details of it. Moreover, it is really a question of three independent pieces of work. The three gentlemen, entirely independently of each other but following a carefully preconcerted plan, each subjected 6, 6 and 4 young physicians and chemists, respectively, to metabolism investi-

gations lasting not less than four months. There were thus $16 \times 120 = 1{,}920$ test days. On 40 of the 120 days, *i. e.*, on 640 days, exact urinary analyses were made. The benzoic acid was given in the following manner: In a fore period of 10 days no benzoic acid was given, then for two months 0.3 gram was given daily, then none for 5 days, 0.6 gram for 7 days, 1 gram for 7 days, 2 grams for 7 days, 4, 6 and 10 grams, respectively, for 7 days, and finally for 10 days no benzoic acid was given (the individual experimenters worked a little differently); the benzoic acid was mixed with the food and given as sodium benzoate. It must also be pointed out that the test persons were not exclusively of especially robust health; in fact, some of rather moderate constitution were taken.

In the first pages of the work is given, briefly, clearly and concisely, what interests us most, the conclusions of the three investigators.

Sodium benzoate in small doses, less than 0.5 gram mixed with the food, is without toxic effect and does not disturb health. Sodium benzoate in large doses, up to 4 grams mixed with the food, showed, upon investigation, no harmful effect in the general sense of the word. In some directions were observed small changes in certain physiological processes, the exact significance of which changes is not known.

According to the investigations, the mixing of sodium benzoate in smaller or larger doses has no unfavorable or deteriorating influence on the value of such food. In this series of experiments, also, the test persons were not in exact nitrogen equilibrium. They were allowed to enjoy at will, within certain limits, quite complicated, extremely varied and dainty foods, the food being merely weighed and analyzed. The daily consumption of food, which, in Germany in such experiments, we keep as nearly as possible uniform in nature and equal in amount, varied not inconsiderably, even though it must be confessed that the daily consumption of food by this method was relatively uniform. We can, therefore, without more evidence, just as easily draw favorable conclusions for benzoic acid from the slight increases in weight which almost all of these well-fed test persons showed as unfavorable ones from the opposite facts in the Wiley experiments. It only shows that benzoic acid is not grossly harmful. Exact metabolism observations in the absolute sense are, also, impossible; only relative values can be discussed exactly, and here, too, the so widely varying nutrition is a somewhat disturbing factor.

The utilization of dry substance, fat and albumin, as we are accustomed to observe it in Germany, is not ascertained here. But I have convinced myself, from a series of values which I have calculated, that no influences on the utilization are to be observed. The corpuscular elements in the urine were not, contrary to the observations of Wiley, increased. No general symptoms were noted, either with the smaller or the larger doses. Of the numberless details of the three investigations we can safely say that, like Wiley's, they show that in almost all special cases nothing essential is changed by the administration of benzoic acid; I may therefore confine myself to picking out a few points. Chittenden expresses, at the end, his extraordinarily favorable opinion that sodium benzoate, up to a dose of 4 grams daily, is no more disturbing or harmful to the human organism than the same quantities of salt. He makes no reservation in any direction, draws no suspicious conclusions from his observations, not even from the establishment, by Wiley's results, that the excretion of benzoic acid as hippuric acid in the urine is somewhat retarded. Long obtains very favorable results; he did, indeed, observe in his uneducated test persons (institute help, etc.) a slight disturbance at times (headache, vomiting, disturbance of sight, excitement) but always found a plausible explanation for it and never feels forced to ascribe it to benzoic acid. Herter noticed, especially with large doses, a slight increase of indican in the urine, but no change in the alkylsulphuric acid, a decrease of the fecal bacteria which evolve gases and an increase of the cocci as compared with other bacteria in

the feces. All these facts find a natural explanation in a somewhat decreased carbohydrate fermentation in the feces and somewhat increased scission of albumen, owing to certain bacteria or bacterial functions being favored by the benzoic acid at the expense of others; no one will interpret this as being hygienically dubious. Herter's values (p. 747) show very prettily the smooth transformation of benzoic acid into hippuric acid; according to his experiments, there is no appreciable retardation. A striking fact in all four of Herter's test persons was the increase of free hydrochloric acid in the expressed gastric juice during large benzoate doses, which could easily be considered as a symptom of irritation of the stomach, but is also capable of other explanations. Gerlach's experiments (see below) showed nothing of this in man or animal. There are many other details in this voluminous book, but they are hardly of significance for the problem and I have tried to bring out anything that might be disadvantageous for benzoic acid.

Most perspicuous to us Germans is the investigation carried out by Dr. Gerlach, of Wiesbaden, by German physiologico-pharmaceutical methods and which, though far behind the American works in scope and extent, can be the more easily surveyed as a whole. Small, medium and large doses were tested on animals and men. I shall not enter into the details of the experiments with rabbits, which were able to take very large doses of benzoic acid without any effects. One gram of benzoic acid was borne subcutaneously by a rabbit for 12 days without harm; a dog was fed with 7.5 grams of sodium benzoate in one dose without disturbing effects; in experiments on the investigator himself, 10 grams of benzoic acid, taken within 3 hours, had no influence on the pulse, respiration, body temperature, digestion and general well-being. (Not every stomach can stand such a dose!—Abstractor.) Two persons daily took 0.5 and 1 gram of benzoic acid and sodium benzoate, respectively, for 80–90 days without any effect. The most careful observation showed no special disturbances of the respiration, pulse or body temperature after taking 1 and 2 grams of benzoic acid and sodium benzoate, respectively. The action of the digestive ferments, gastric juice, trypsin and the diastatic ferments was not influenced by benzoic acid and sodium benzoate. Three and five grams of benzoic acid and sodium benzoate had no influence on the quantity, acid content and digestive power of the gastric juice of a dog subjected to the Pawlow operation. Half a gram and one gram of benzoic acid and sodium benzoate, respectively, taken by the experimenter at a test breakfast, exerted no influence on the free hydrochloric acid, total acidity and digestive power of the gastric juice, collected one hour after the breakfast. In metabolism experiments on men, it was found that 1 gram benzoic acid or 1.5 grams sodium benzoate (each taken 6 successive days) had no effect whatever on the stock of albumin in the body nor on the utilization of the nitrogenous substance and fat in the food. Eighty-two doses of 1 gram each of benzoic acid, taken within 86 days, and 88 doses, taken within 92 days, showed no unfavorable effects on the general well-being, body weight, etc. At the end of the experiments, it was found that the benzoic acid, whether mixed foods or chiefly vegetables were eaten, was completely transformed into hippuric acid. Gerlach collects from the literature a large number of cases, not all of which are contained in my earlier review, and which show that large doses of benzoic acid can be taken by healthy and by sick people without harm, and he concludes with the words:

> Neither the observations made in medical practise and reported in the literature nor the large number of experiments which have been carried out for the purpose seem to justify the assertion that benzoic acid and sodium benzoate in small quantities, such as they are eaten in preserved foods, are able to produce any harm whatever. The attempt to prohibit the use of benzoic acid and benzoates as a preservative would therefore not be warranted by the very copious scientific material at hand.

While the American investigators and Gerlach thus reach conclusions which could not be more favorable to those who espouse the cause of benzoic acid, the question as to the admissibility of its use is not yet wholly cleared up in Europe, especially in Germany, and an unfriendly disposition predominates. France summarily prohibited the use of benzoic acid as early as 1888, long, therefore, before its thorough investigation; in Austria, also, it was excluded from use by a decision of the chief of the Board of Health on the 16th of December, 1899, and recently again he has refused his sanction.[5] The Landesmedizinalkollegium of Saxony has likewise refused to authorize its use.[6]

In Germany the law takes no firm stand against benzoic acid. The acquittal of dealers who introduced margarine preserved with benzoic acid into the trade in Saxony is interesting. The produce dealer Gertrud Eberlein, née Herber, who had been fined 2 Marks for dealing in margarine with 0.05 per cent. benzoic acid, had started a long trial in three courts which, however, had ended with her acquittal in the assessors's, district and provincial courts. Injury to health by such doses of benzoic acid no one could maintain; the opponents of benzoic acid among the judges asserted that benzoic acid is really a preservative, that the addition of benzoic acid makes it possible to store margarine, but that the public demands fresh margarine and that the stored product is not as good as the fresh margarine. The arguments frequently made by the judges in favor of acquittal were the following: Benzoic acid has thus far not been prohibited in Germany; it occurs in cowberries in considerable quantities; in the amounts in question it is harmless; the nutritive value, wholesomeness and usefulness of the margarine is not changed; it is therefore a preservative which, where applicable, offers great advantages long sought for, without any disadvantages. The following judicial verdicts concerning benzoic acid in margarine have come to my knowledge: (1) Acquittal of the manufacturer F. A. Isserstedt, Elberfeld, before the assessor's court of Solingen on November 11, 1908.[7] (2) Acquittal of the manufacturer Held, Schkeuditz, before the assessor's court of Schkeuditz.[8] (3) Acquittal of the same before the provincial court of Halle. Appellate proceedings on May 3, 1910.[9] (4) Acquittal of the merchant G. Eberlein before the assessor's court of Dresden in June, 1910.[10] (5) Acquittal of the same before the district court of Dresden on February 8, 1911.[11] (6) Acquittal of the same before the provincial court at Dresden on June 7, 1911.[12]

The following express themselves in favor of the use of benzoic acid (for margarine): (1) Professor Eccles in his book, "Die Bedeutung der Konservierungsmittel für die menschliche Ernährung in wirtschaftlicher und hygienischer Hinsicht"; (2) von Vietinghoff-Scheel;[13] (3) Gustav Hefter;[14] (4) the food chemist, Dr. Langfurth, Altona;[15] (5) the food chemist, Dr. Postler, Mühlhausen;[15] (6) Professor Klostermann, Halle; (7) the food chemist, Dr. Niederhäuser, Wiesbaden;[16] (8) the food chemist, Dr. Lührig, Breslau;[16] Professor Frerichs, Bonn.

Recently the Prussian Committee on Medical Affairs has expressed itself, in a decidedly surprising manner, in favor of the prohibition of benzoic acid as a preservative for human foodstuffs and luxuries. The referees, Privy Councillors Heffter and Abel,[17] frankly acknowledge, indeed, the conclusiveness of the

[5] *Das österr. Sanitätsw.*, 1910, Nos. 13–15.

[6] *Jahresb. Medizinalw. Königsreichs Sachsen*, 1905, 193.

[7] *Z. Marg.-Ind.*, 1903, 69.

[8] *Ibid.*, 1910, 113.

[9] *Z. Marg.-Ind.*, 1910, 113.

[10] *Ibid.*, 1910, 152.

[11] *Ibid.*, 1911, 69.

[12] *Ibid.*, 1911, 159.

[13] *Chem. Ztg.*, 1909, 181; 1910, 904.

[14] "Technologie der Fette und Oele," Vol. 3, p. 192.

[15] *Z. Marg.-Ind.*, 1910, 152.

[16] *Ibid.*, 1911, 69; cf. also *Chem. Ztg.*, 1911, 28, 53.

[17] "Die Verwendung von Benzoesäure und ihren Salzen zur Konservierung von Nahrungsmitteln," *Vierteljahrschrift ger. Med. u. öff. Sanitätswesen*, 41, 330 (1911).

proof afforded by the investigations of Chittenden, Long and Herter that small amounts up to 0.5 gram are harmless to the human body, but they continue:

> Whether larger amounts (quantities of several grams) could, in the long run, be borne equally without effect by everybody can not as yet be answered with certainty. The experiments of the American scientists in this connection are of too limited extent and suffer from certain limitations so that they can not be considered as proof of universal harmlessness.

With these carefully worded sentences we can, on the whole, agree without, however, drawing the conclusion therefrom that benzoic acid as a preservative is to be prohibited. For, first of all, we must consider that there are many food constituents which, under such a system, we might mistrust and likewise prohibit. I might mention hops in beer, sugar in preserves and salt in salt meat. There are, beyond doubt, many of whom it can be said with certainty that not only the repeated consumption of such things, but even a single meal off of them, is prejudicial to their health. Those suffering from urethral diseases can not stand hops, diabetes patients and persons with stomach troubles can not stand preserves, kidney sufferers can not stand salt, yet such sufferers are continually eating these things, consciously or unconsciously, without any one prohibiting them to the world. Secondly, from what has been said above it is evident that benzoic acid, considering its preservative action on acid substances poor in albumin (for others it does not come into consideration), is remarkably harmless to the healthy and the sick—with no other preservative have such daring experiments been performed on sick persons without harm. If a healthy or a sick person were given just once ten times the amount of tobacco, alcohol or even of sugar that is usually taken rationally, the results would be far worse than when, instead of 0.1 to 0.5 gram benzoic acid, 1–5 grams are given. I offered this same argument, with equal justification, many years ago to those who persisted in considering saccharin as a poison.

Thirdly, no one has thus far asked more than that it be considered whether certain special food products might not, under proper declaration, be treated with small quantities of benzoic acid. No one, except perhaps a few manufacturers, has ever dreamed simply of a permission to add benzoic acid to foods. On the contrary, there can not be much doubt that for meat and meat preparations benzoic acid and benzoates should be prohibited; they have little preservative power and when mixed with other substances (phosphates) they help to preserve a fresh color, while the decomposition goes on; like the sulphites, therefore, they give a deceptive appearance of better condition, and according to the Heffter-Abel decision even a slight odor of putrefaction of minced meat is masked or removed by the admixture of 0.25 per cent. of benzoic acid or benzoates. No one will demand the free use of benzoic acid for tinned vegetable preserves; in these cases nothing but heat is necessary. The question is whether its use for preserving egg yolks, tomatoes, lemon juice and similar preparations, as well as margarine (and this is at present the most important), can be permitted. The first-named preparations, egg yolks, tomatoes, lemon juice, are of subordinate interest as regards public nutrition and can be passed without further discussion; even the most timid would not need to fear gravely for the public health if benzoic acid in such preparations were allowed, a statement as to the amount used being required. Personally, I am unconditionally in its favor when it is proved that these products can be prepared in a non-perishable form and kept without preservatives only with great difficulty or not at all.

The question as to allowing the use of benzoic acid in margarine, which has become a real public foodstuff, demands special treatment. One hundred and fifty million kilograms of margarine are said to be produced annually in Germany and a considerable part of it used in this country.[18] It would be very difficult today, especially for those living in cities, to protect themselves against margarine in their food. Any one in a hotel or purchasing fatty

[18] *Z. Marg.-Ind.*, 1910, 134.

confectionery or bakery wares will at once make the acquaintance of margarine; only the preparation of all food in one's own house insures safety. Margarine has won this position in spite of all compulsory declarations, in spite of the foreign-sounding name, because it fills the need of the people for a cheap fat. Leaving out one recent case where the criminal negligence of a firm in carelessly selling a poisonous foreign fat caused many cases of illness and some deaths, so far there has not been much with which margarine can be reproached.

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SCIENTIFIC BOOKS

Planktonkunde. Von DR. ADOLF STEUER. Leipzig und Berlin, Teubner. 1910. Pp. xv + 723. Mit 365 Abbildungen im Text und 1 Tafel.

Leitfaden der Planktonkunde. Von DR. ADOLF STEUER. Leipzig und Berlin, Teubner. Pp. 382. Mit 279 Abbildungen im Text und 1 Tafel. M. 7. Geb. M. 8.

Many additions have been made to our knowledge of the floating life of the sea and its counterpart in fresh water, the plankton, since Haeckel published his highly theoretical "Plankton-Studien" with its elaborate but never generally adopted nomenclature and classification of this domain of life. The work of the Kiel school and its Plankton Expedition and Henson's Danaid task of taking a census of the sea, the *Valdivia* expedition with its superbly illustrated reports, the various expeditions of the Prince of Monaco, of the U. S. Steamer *Albatross* under the direction of the late Alexander Agassiz, the work of the International Commission for the Investigation of the Sea and the investigations of the fresh-water stations in Denmark, Germany, Switzerland and the United States have resulted in the perfection of instruments and methods and the accumulation of a mass of results. Steuer's treatise on planktology thus finds the time opportune for appearance and fittingly forms a volume in the Teubner series ("Naturwissenschaft und Technik in Lehre und Forschung") under the editorship of Professors Doflein and Fischer, of Munich.

The first work is comprehensive in plan, covering all phases of the varied content of the subject of the life of the sea and of fresh water. The first chapter of the work deals with water, its distribution on the earth, chemical constituents, temperature changes, its relations to light and pressure, its color and odor, and its movements under meterological influences. Other chapters treat of methods, quantitative, qualitative and statistical, of plankton investigations, of the adaptations of the plankton to flotation with special reference to viscosity in relation to temperature and season, of adaptations in color, and of phosphorescence.

It appears that the data cited by Steuer are quite inadequate to establish his thesis that the organisms of the plankton as compared with those of the bottom and shore are characterized by a relatively low rate of reproduction. It is not the pelagic nature of the organism which is the cause of the low rate of reproduction often observed in plankton-poor lakes but rather a poverty stricken habitat. The herring fisheries, the chalk beds of past ages, the abundant and rapidly fluctuating plankton of enriched rivers, the occasional sudden outbursts of the "mare sporco," all bear indisputable evidence of the capacity of pelagic life to respond to opportunities for rapid multiplication. This erroneous idea that the plankton has a relatively slight capacity for reproduction is correlated with another all too widely applied idea, namely, that the tropical seas are relatively barren. The facts are that fresh waters and the sea vary greatly in different regions and at different seasons in the amount of life they contain. In warm waters the chemical processes of life are so accelerated that life cycles are shortened and decay is hastened, while in colder waters growth and decay are slower and individuals accumulate though the total product in the two regions in a given time may be the same. Food supply and temperature affect